



Solanum sisymbriifolium Lam. (Solanaceae): a new invasive undershrub of the old-fields of northeastern Uttar Pradesh

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Abstract: *Solanum sisymbriifolium* Lam. (Solanaceae), an undershrub species, was first identified at an upland site in the suburb of Gorakhpur town during a broad survey on the distribution and abundance of grassland and old-field species of northeastern Uttar Pradesh. The species was first noticed in August 2012, and by the start of 2014 it showed a highly significant increase in its number and vegetal cover. Morphologically the species provides a spectacular plant body by virtue of numerous long orange-red spines found along the stem and leaves to the calyx, large white flowers with bright yellow anthers, and its red ripe fruits present for most of the year. The plant body is largely unpalatable and also resistant to grazers. The rapid spread of this species within a short span of about two years indicates the potential for this perennial shrub as a harsh invader of upland sites of the region. A brief account of habitat and population size along with a morphological description and line drawing is provided for easy identification of the species, which is not yet reported from Uttar Pradesh.

Key words: *Solanum sisymbriifolium*, new invader, northeastern Uttar Pradesh, India

The undershrub species *Solanum sisymbriifolium* Lam. (Solanaceae) was first identified at an upland site in the suburb of Gorakhpur town, during a broad survey and analysis of the distribution and abundance of grassland and old-field species of northeastern Uttar Pradesh. The species was first noticed in August 2012 and by the start of 2014 it showed a highly significant increase in its number and vegetal cover. Morphologically the species provide a spectacular plant body by virtue of numerous long orange-red spines distributed from the stem and leaves to the calyx, and large white flowers. *Solanum* Linn. is a large and diverse genus belonging to the cosmopolitan family Solanaceae. This genus constitutes many economically important species

widely distributed throughout tropical and temperate regions, with centers of diversity in Central and South America and Australia (Edmonds 1978; D'Arcy 1991). In India, the genus *Solanum* is represented by 42 species. A total of 8 wild species of *Solanum* have been recorded from northeastern Uttar Pradesh (Srivastava 1976; Saini 2010). However, *Solanum sisymbriifolium* has, thus far, remained unnoticed or absent from the region. With the addition of this newly recorded species, the total regional number of *Solanum* species is increased to nine.

Solanum sisymbriifolium is a viscid and very prickly erect undershrub species, and is commonly known as wild tomato, kanta begun, kantikari (Bengali), or sticky nightshade (English) (Figure 1). It has over 15 synonyms. The roots of the plant are used as a diuretic, analgesic, contraceptive, antisyphilitic and hepatoprotective, while the aerial parts are used in treatment of diarrhea, and infections of respiratory and urinary tracts. The fruit is consumed regularly by indigenous birds and it is also a source of solasodine, which is used in the synthesis of corticosteroids and sex hormones (Hill and Hulley 1995). Its fruits are globose-obovoid and shining red when ripe. It acts as an invasive weed in some parts of its range by out-competing local vegetation.

This species is a native of Central and South America (Hill and Hulley, 1995) and was introduced to North America, Europe (Spain, the Netherlands), Africa (South Africa, Congo, Swaziland), Australasia (Australia, New Zealand) and Asia (India, China, Taiwan). It was introduced in India around 1980 (Jain and Borthakur 1986). It is now mainly distributed in Andhra Pradesh, Assam, Bihar, Gujarat, Kerala, Karnataka, Maharashtra, Manipur, Orissa, Punjab, Sikkim, Tripura and West Bengal. In north India, it was reported in Punjab (Saha and Datta, 2013). However, as yet there are no published records of this species from other states in India, including Uttar Pradesh.



Figure 1. Habit, flowering and fruiting of *Solanum sisymbriifolium* Lam. **A**, plant body with flower under natural habitat; **B**, bunch of flower buds with numerous prickles; **C**, unripe mature berry; **D**, Ripe berry.

The study area (located between 27°05' to 27°40' N, 083°30' to 84°00' E) is characterized by quite even topography and fine alluvial deposits drained by several rivulets. The landscape comprises a mosaic of human habitations, agricultural fields, grasslands, commercial plantations and forests. The climate is typically monsoonic with three distinct seasons. Relative humidity ranges between 74–87% and the mean temperature range is 12–39°C. Diverse topographic features here offer many habitats and microhabitat types for a variety of herbs to grow across the grassy landscape of the region. The soil is largely a Gangetic alluvium, ranging from clayey to sandy loam in texture.

During an intensive survey on the distribution, population status and abundance of grassland and old-field species across northeastern Uttar Pradesh, *Solanum sisymbriifolium* Lam. was spotted only at two habitats of an upland site adjacent to a rivulet in the suburb of Gorakhpur town. Reference to a regional flora (Srivastava 1976; Saini 2010) and other research works (Srivastava et al. 2014) showed no record of this species from Uttar Pradesh. Specimens were collected, crosschecked and compared with various other *Solanum* species (Deb 1981, 1983; Hooker 1885; Prain 1903; Kanjilal 1939). Habitat characteristics, population size, area cover and various morphological and phenological features were observed. Morphological features (plant height, number of leaves, spines, flower and seed size, etc.) were measured from randomly-selected mature individuals. The habitat conditions, population size and individual density at the two habitats were also recorded.

Solanum sisymbriifolium is a perennial erect, rhizomatous

shrub, about 1 m in height. The stem and branches are viscid, hairy, sparsely glandular, stellate and with simple hairs. Prickles dense, subulate, 10–12 mm long, very sharp. Leaves alternate, lamina ovate-oblong, 28 × 14 cm, area ca. 100 cm², deeply pinnatisect, much prickles on both the upper and lower surface of midribs and veins, sparsely stellate hairs, lobes rounded, sinuate, more than one spine per cm² of leaf area. Prickles about 20 mm long, base 0.2 mm. Petioles 4–7 cm, prickly as stem. Raceme with 5–10 flowers. Peduncles 3–7 cm long, pilose, hairs glandular and simple, densely prickly. Pedicels slender, glandular-pilose, and slightly prickly, >10 mm. Flowers white, calyx green, membranous, 9 × 3 mm, deeply 5-parted, lobes lanceolate acuminate. Corolla white with slightly bluish violet lining on lower surface, 30–35 mm in diameter, rotate, stellate, lobes broadly triangular. Stamens 5, filaments 2 mm long, slender, glabrous. Anthers lanceolate, 7 mm long, attached to petals. Ovary ovoid, 2 mm, superior, glabrous, style 13 mm long, stigma bilobed. Pedicels deflexed on fruiting with accrescent calyx. Berry bright red, 10 mm across, globose, covered by enlarged, reflexed and prickly calyx; 85–120 seeds per fruit, seeds 2 mm in diameter (Figure 2). Flowering and fruiting occurs round the year. Sexual reproduction is predominant in *Solanum sisymbriifolium* (Hill 1994). The procumbent branches often develop roots at the point of touch with the ground and thus propagate vegetatively. Subsequently, the rooted branch develops as separate individual though it may still remain connected belowground with the parent plant for whole of the current favorable growth period. During the period of water stress, the plant body apparently

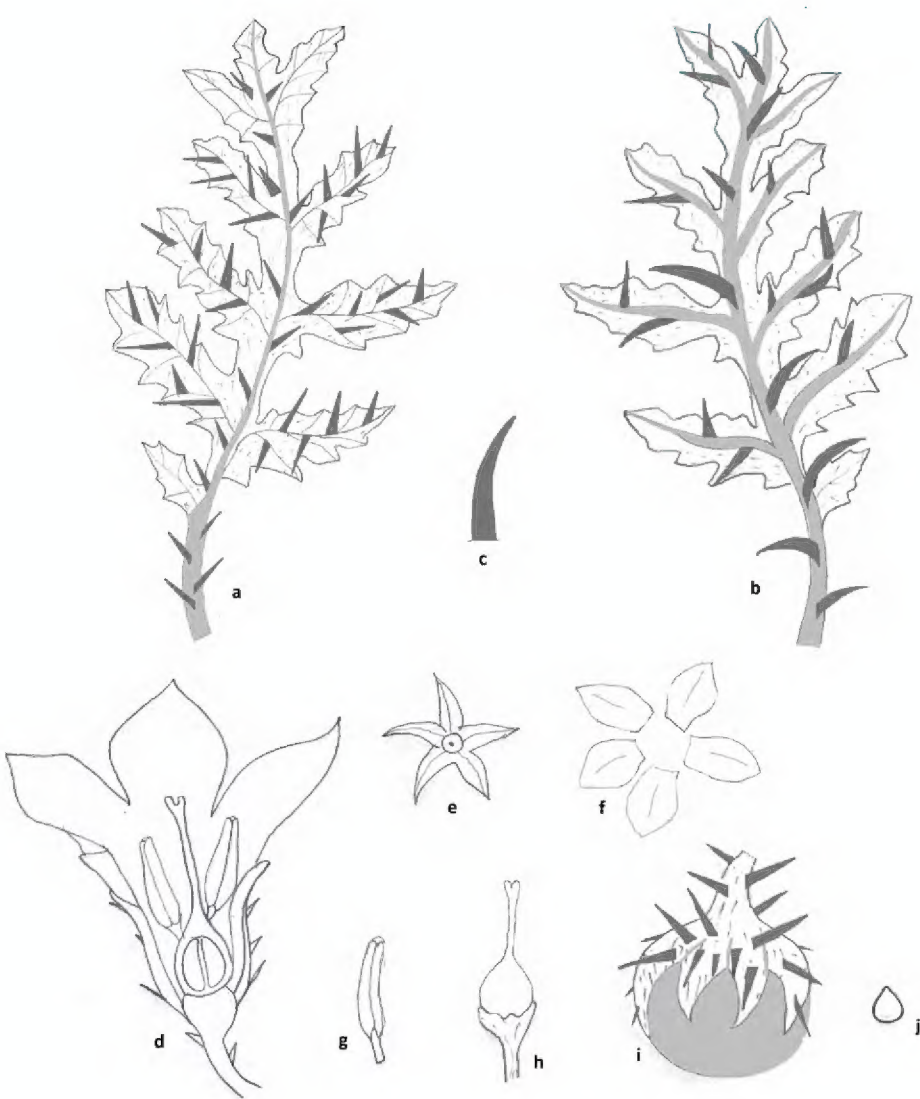


Figure 2. Line diagram of different parts of *Solanum sisymbriifolium* Lam. **a**, leaf, dorsal surface; **b**, leaf, ventral surface; **c**, a single prickly; **d**, longitudinal section of flower; **e**, calyx; **f**, corolla segments; **g**, a single stamen; **h**, gynoecium; **i**, a mature fruit; **j**, A single seed.

dies. With the onset of favorable soil moisture conditions, it may sprout profusely. The voucher specimen (Pt. DDU GPU-4201) was deposited at Gorakhpur University Herbarium, Gorakhpur.

Most of the plant parts die back in dry summer. The ripe fruits are retained on drying branches and can be dispersed by wind like tumble weeds, spreading seeds along the way (Boyd and Murray 1982). In all probability, the spread of the species to the suburb of Gorakhpur town might have occurred through the agency of flood water of the river Rohin. The fruiting branches and mature fruits can disperse by floating over long distances along rivers and streams, especially during floods. Spread is also possible by several other means including birds and wild animals. These plants produce large quantities of fleshy fruit, which are favored by frugivorous birds, which facilitate the rapid dispersal of seeds into new habitats. The seeds germinate quickly, especially in disturbed soil, often below the parent plant where they are dropped from burst fruit (Hill 1994). At highly disturbed areas where *S. sisymbriifolium* may behave as

annual plant, the seedlings need not compete with their parent plants. In contrast, in many plant species, seedlings emerging from seeds that fall below the parent plants are subject to density-dependent mortality from the parent plants, resulting in reduced survival (Coates-Estrade and Estrade 1988).

The population size of *Solanum sisymbriifolium* varied in the two close-by habitats differing in the degree of slope or retention of soil moisture. The species showed higher population size as well as individual density on sloping habitat, as compared to the plain habitat (Table 1). The nearest neighbors of the species were *Acalypha ciliata* Forsk, *Ageratum houstonianum* Mill. and *Hemigraphis hirta* (Vahl.) Anders. Other herbaceous associates close to its population were *Achyranthes aspera* Linn., *Alternanthera sessilis* (Linn.) R. Br. ex DC., *Amaranthus viridis* Linn., *Blumea* sp., *Boerhaavia diffusa* Linn., *Cleome gynandra* Linn., *Croton bonplandianum* Boil., *Cynodon dactylon* (Linn.) Pers, *Eclipta alba* Linn., *Parthenium hysterophorus* Linn. and *Sida acuta* Burm f. The growth strategy of the species reveals that it may occupy a variety of old-field habitats, though its preference is towards upland habitats. It is known to act as an invasive weed in some parts of its range by out-competing local vegetation. The species is known to be favored by localized, short-term disturbances such as ploughed fields, road-sides, wastelands, landfills and cultivated crops in its region of origin and the herbivore fauna of *Solanum sisymbriifolium* is rare (Hill and Hulley 1995). The species has recently become a serious pest of agricultural lands and has been proclaimed a noxious weed in South America. Despite being indicative of disturbed habitats, the weed was found to be invasive in agricultural suburban areas (Becker and Frieiro-Costa 1988).

The species is not yet reported from Uttar Pradesh. In all probability, it is a new arrival to the old-fields of northeastern Uttar Pradesh, and has started to flourish as an invasive undershrub of the upland area of Gorakhpur. The efficient regeneration, quick growth, long period under flowering and fruiting, production of plenty of viable seeds and preference to disturbed upland and wasteland habitats makes the species a potential invader which is likely to spread fast across northeastern Uttar Pradesh. The study of population dynamics and natural plant associates of this species, alongside its community features, may provide evidence about the degree of threat of this invader to the diversity of local native plants of regional grasslands and old-fields.

Table 1. Habitat conditions, population size and individuals density of the two populations of *Solanum sisymbriifolium* Lam., noticed in the suburb of Gorakhpur town.

Population	Habitat conditions	Population area cover (m ²)	Population size (no. of individuals)	Individual density /m ²
1	Sandy, below average moisture, open, sloppy	500	22	0.044
2	Sandy, Average Moisture, open, plain	250	6	0.024

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